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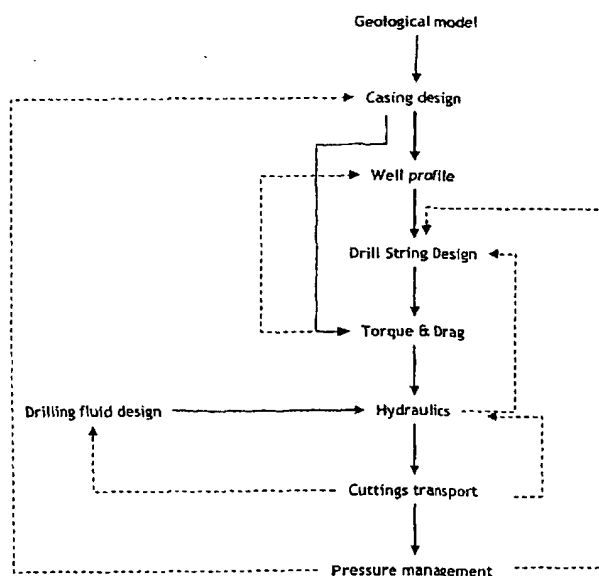
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(54) Title: METHOD AND SYSTEM FOR THE DESIGN OF AN OIL WELL



(57) Abstract: The invention is concerned with the design of oil wells by defining a number of design parameters, some of which are interdependent. The invention makes use of successive optimisations. Input data are selected for a first parameter and varied to achieve a first optimisation. The process is repeated for a second parameter whose input data includes the first parameter, and then repeated for each other of the defined parameters. The design parameters may be presented to the user via a graphical interface such as a virtual reality view.

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1 METHOD AND SYSTEM FOR THE DESIGN OF AN OIL WELL

2

3 This invention relates to systems and methods for
4 use in designing oil wells and in controlling the
5 drilling of oil wells.

6

7 The design of an oil well requires a number of
8 activities. In a typical example, these are:

9

10 1. Design well path - being the path the well will
11 take from the surface to and through the
12 reservoir.

13 2. Design casing scheme - being the placement, size
14 and material characteristics of the casing
15 cemented in the well.

16 3. Design drill string - being the design of the
17 drill string, bottom hole assembly and drill bit
18 selection for each section of the well.

19 4. Torque and drag calculations - being the
20 calculation of static and dynamic frictional drag
21 in the well bore due to the movement of the

1 casing and/or drill string during rotary
2 operations.

3 5. Drilling fluid design - being the design of the
4 drilling fluid and determination of rheological
5 properties.

6 6. Hydraulics design - being the design of the
7 drilling fluid, flow rate, flow regime and
8 pressure regime along the drillstring, through
9 the bit and along the annulus.

10 7. Pressure management - being the management of the
11 pressure in the wellbore and the balance between
12 the wellbore pressure, formation fluid pressure
13 and formation fracture pressure.

14

15 Ideally, each of these steps would be optimised
16 against known constraints or conditions, which may
17 include subsequent constraints or conditions arising
18 from the output of later steps in the process.

19 Thus, some degree of iteration between steps is
20 necessary.

21

22 Current practice is to complete each step
23 individually using manual data input or data
24 selected from a database. Each step is completed
25 before going onto the next step. Each step is
26 completed when certain satisfying conditions are
27 met. These satisfying conditions might not be the
28 optimum solution either for the step under
29 consideration or in terms of the total well design
30 after all the steps have been completed. Any
31 contradictions between the output from a later step
32 and a former step are resolved by returning to the

1 former step to find an alternative solution that
2 satisfies the desired condition. The end result is a
3 set of conditions that have been satisfied and not
4 an optimum solution. For example, step A is
5 completed and the output meets set criteria. Data
6 from step A is entered along with other data into
7 step B. If the output from step B meets set
8 criteria, both step A and step B are said to be
9 optimised. This, however, is not the case; they can
10 only truly be said to satisfy certain conditions,
11 which is not an optimum. An optimum will be reached
12 when the sets of conditions for both step A and step
13 B are optimised.

14

15 One aspect of the present invention is directed to
16 improving this prior art by using concurrent or
17 recursive iterations to provide the best overall
18 optimisation within the defined conditions and
19 constraints.

20

21 The use of multiple and inter-related optimisations
22 can cause problems to the well designer owing to the
23 quantity of factors to be assimilated. Another
24 aspect of the invention relates to assisting the
25 designer in this area by conducting the design
26 process within a graphical user interface.

27

28 A further aspect of the invention makes use of the
29 same principles in controlling the physical
30 drilling/casing process.

31

1 US4,794,534 describes a method of simulating future
2 drilling activities utilising drilling data as
3 recorded at the rig site. The data is called into
4 use by the operator if there is a perceived variance
5 between the planned and actual drilling operations.
6 The assumption within the text of this patent is
7 that each aspect of well design requires its own
8 simulator.

9
10 This document acknowledges that the initial well
11 design process and the real time simulation of
12 future drilling activities are not related
13 activities.

14
15 The description clearly states that the real time
16 simulator would be used in the event that a
17 discrepancy is noticed between actual and planned
18 operations. The assumption here is that the planned
19 operations are optimum and any non variance means
20 that the operation is continuing in an optimum way.

21
22 US6,612,382 describes an iterative drilling
23 simulation method and system for enhanced economic
24 decision making. The patent describes a method of
25 determining drill bit performance given certain rig
26 and geological characteristics. This document is
27 only concerned with bit selection and operation.

28
29 Accordingly, from one aspect the present invention
30 provides a method of designing an oil well,
31 comprising:

1 (a) defining a plurality of design parameters
2 each of which is determined by a number of input
3 data, the input data for at least some of the
4 parameters including one or more of the other
5 parameters;

6 (b) providing, for each of the design
7 parameters, conditions or constraints which must be
8 met;

9 (c) selecting input data for a first design
10 parameter such that the parameter falls within the
11 conditions or constraints;

12 (d) varying the input data for the first design
13 parameter to achieve an initial optimisation of the
14 parameter;

15 (e) for a second design parameter whose input
16 data includes the first parameter, selecting other
17 input data such that the second parameter falls
18 within the conditions or constraints;

19 (f) varying said other input data for the
20 second design parameter to achieve an initial
21 optimisation of the parameter;

22 (g) varying the input data for the first
23 parameter to further optimise the second parameter;
24 and

25 (h) repeating steps (e) to (g) for the
26 remaining design parameters.

27
28 The design parameters will typically be selected
29 from activities 1. to 7. above.

30
31 The first aspect of the invention also provides a
32 system for use in oil well design, comprising:

1 a database storing a plurality of design
2 parameters each of which is determined by a number
3 of input data, the input data for at least some of
4 the parameters including one or more other
5 parameters;
6 the database also storing for each parameter
7 conditions or constraints which must be met;
8 means for selecting input data for each of the
9 parameters;
10 calculating means for calculating a selected
11 parameter from its input data; and
12 means for optimising a given parameter by
13 altering the input data of another parameter which
14 forms an input to said given parameter.
15
16 The means for selecting input data may comprise a
17 manual input device such as a keyboard, or may
18 comprise an input data database from which items may
19 be selected by a user.
20
21 From another aspect, the present invention provides
22 an oil well design system in which design parameters
23 are presented to a user via a graphical user
24 interface, preferably the graphical user interface
25 comprises a virtual reality interface or view. The
26 system is preferably in accordance with the first
27 aspect of the invention. The graphical user
28 interface is preferably adapted to display the
29 degree of system optimisation, for example by a
30 system of traffic light displays or through any
31 other visual indicator.
32

1 A further aspect of the invention resides in a
2 method of forming an oil well in which a model of
3 the predicted wellbore conditions is constructed;
4 real time data is generated by sensors in the well
5 and the drilling rig; said real time data is used to
6 compare the actual with the predicted conditions and
7 differences are used to adjust drilling parameters
8 or to adjust the model; an updated model is created;
9 and the process is repeated as necessary.

10

11 The model may be constructed using the design method
12 or system defined above.

13

14 Embodiments of the invention will now be described,
15 by way of example only, with reference to the
16 drawings, in which:

17

18 Fig. 1 is an overview of a well design process;

19

20 Fig. 2 is a detailed flowchart of one example
21 of well design method;

22

23 Fig.3 illustrates the method applied to
24 underbalanced well design;

25

26 Fig. 4 is an overview of a second embodiment of
27 the invention, applied to the design and real-
28 time control of a drilling process;

29

30 Fig. 5 shows the basic control system layout
31 for the process of Fig. 4; and

1 Fig. 6 is a flow diagram of a further
2 embodiment.

3
4 Well design comprises a number of activities
5 including, but not limited, items 1-7 listed above.

6
7 Each of steps 1 - 7 are optimised against known
8 constraints or conditions which may include
9 subsequent constraints or conditions arising from
10 the output of later steps in the process thus
11 necessitating some degree of iteration between
12 steps.

13
14 The current state of the art is to complete each of
15 steps 1 - 7 independently using manual data input or
16 data selected from a shared database input into each
17 subsequent step in the operation.

18
19 The present invention provides a way of designing
20 the well whereby the iterations are completed
21 concurrently and not sequentially and where the
22 input/output is performed through a single graphical
23 user interface (GUI). The process as described will
24 allow a well engineer or well engineering team to
25 design a well, determine the operations envelope,
26 understand the risks and prepare operating
27 procedures to mitigate the risks. This is
28 demonstrated in Figure 1.

29
30 Figure 2 represents the new well design model
31 showing some of the iteration steps in the process.
32 From the diagram it can be seen that there are

1 numerous iterations requiring data entry from
2 various steps in the process.

3

4 Hitherto, practice has been for each step of the
5 process to be completed before going onto the next
6 step. Each step is completed when certain satisfying
7 conditions are met. These satisfying conditions
8 might not be the optimum solution either for the
9 step under consideration or in terms of the total
10 well design after all the steps have been completed.
11 For instance, step A is completed and the output
12 meets set criteria. Data from step A is entered
13 along with other data into step B. If the output
14 from step B meets the set criteria both Step A and B
15 are said to be optimised. This is not the case and
16 they can be said to satisfy certain conditions only
17 which is not an optimum. An optimum will be reached
18 when both sets of conditions/criteria or constraints
19 in step A and step B are optimised.

20

21 The more numerous the number of steps in the process
22 the more sets of conditions or constraints need to
23 be met. It is also common practice to add
24 constraints due to non engineering factors such as
25 logistics and supply of material. If these sorts of
26 constraints are invoked at the start of the well
27 design process a true optimum condition cannot be
28 realised and a true understanding of the operational
29 risks cannot be appreciated. A system whereby all or
30 at least a far larger combination of inputs can be
31 tested will lead to a better well design solution.

32

1 One example of a set of activities, constraints and
2 iterations is given in Table 1.

3

4 The difficulty of such a broad iterative methodology
5 can be reduced by the use of interactive
6 visualisation in place of the conventional graphs
7 and static line drawings.

8

9 The user interface of the proposed system is a 2-D
10 or 3-D "virtual reality" environment that allows the
11 user to manipulate the environment and change
12 conditions within the environment and to see the
13 effects of such changes on all aspects of the well
14 design. In this way a series of adjustments, of say
15 drill string outside diameter can be quickly tested
16 against hydraulics, torque and drag, drilling
17 tendency and so on. A true optimum condition can be
18 determined very quickly. The system can be likened
19 to parametric visualisation.

20

21 As an example we can consider the case of modelling
22 wellbore conditions in an underbalanced well.

23

24 The conventional method would be to develop a static
25 model assuming an end condition, that is the final
26 depth of the well. A static representation of data
27 such as pressure profile and flow regime under
28 certain flow rate conditions is provided.

29

30 In the virtual well engineer method the well would
31 be drilled within the virtual reality environment
32 (here referred to as the graphical user interface

1 GUI). The well depth can be increased in increments
2 and the pressure and flow regimes displayed visually
3 on the GUI. At each increment of depth flow
4 conditions such as flow rate of liquid phase and
5 flow rate of gas phase can be adjusted through
6 manipulation of icons, bars or some other
7 representation in the GUI and the results in terms
8 of for instance, flow regime, pressure profile,
9 inflow performance, cuttings cleaning, cuttings bed
10 movement and so on displayed visually and
11 concurrently. The full set of conditions and results
12 are displayed in this virtual reality. At each
13 increment of depth input conditions can be varied to
14 achieve an optimum operating condition (Figure 3).
15 These simulated conditions can then be used to
16 develop an along hole operating envelope and a set
17 of operating procedures. Risks, such as stuck pipe
18 due to poor hole cleaning can be simulated and
19 reconciled through the virtual reality system and
20 form part of the risk mitigation processes within
21 the operating procedures.

22

23 As a further refinement, the virtual reality GUI can
24 use simple display methods to demonstrate the degree
25 of system optimisation. This could be in the form
26 of, for instance a series of traffic lights with
27 each set of traffic lights representing one aspect
28 of the design process and its relationship with all
29 other linked processes. As each process is optimised
30 the traffic lights change state from red to green.
31 The system is optimised when the maximum number of
32 green lights is displayed. An alternative method

1 might be the use of cross referencing matrices which
2 change colour as the desired optimum state is
3 reached.

4

5 This system can be set up to automatically determine
6 the optimum condition given a set of initial
7 constraints or conditions. Methods such as fuzzy
8 logic or constraint satisfaction can be used.

9

10 As a further refinement the system can include a
11 risk based economic model which can be used to
12 determine the cost effectiveness of operating
13 decisions.

14

15 A second embodiment of the invention relates to a
16 method of controlling well drilling operations by
17 the use of a real time simulator. As shown in Fig.
18 4, the simulator constructs a model of the predicted
19 wellbore conditions using, in the first instance
20 input data from the user. The output gives a
21 theoretical model of the drilling program.

22

23 Well site sensors are linked to the simulator, with
24 the simulator being located at the rig site or
25 remotely with communication between the simulator
26 and rig site. These sensors will include surface
27 sensors and downhole sensors to include, for
28 instance, pump flow rate, surface pressure, downhole
29 pressure, weight on bit and so on.

30

31 As the well is drilled real time data from the
32 sensors is taken by the simulator and the model

1 recalculated to compare actual drilling conditions
2 with the predicted model and to give a model of
3 conditions to be encountered as drilling progresses.

4
5 Variances between actual conditions and the
6 predicted model can be used to improve system
7 performance or improve the model on which future
8 predictions of performance are based. The drilling
9 process becomes a learning process.

10
11 The basic control system layout is shown in Fig. 5.

12
13 The process model is one of:

- 14
- 15 1. Model well using simulator
 - 16 2. Receive well and rig measurements
 - 17 3. Adjust model or adjust drilling parameters
 - 18 4. Develop new model
 - 19 5. Continue

20
21 The simulator displays the model and actual
22 conditions in a virtual reality representation of
23 the data. Thus the operator can see the influences
24 of each operating condition on all relevant aspects
25 of the process. As an example the simulator will
26 display torque and drag (friction) along the
27 drillpipe and also display, for instance cuttings
28 bed build up along the wellbore. The actual torque
29 and drag data can be used to remodel hole cleaning.
30 From this the operating conditions of flow rate and
31 drill string RPM can be adjusted to reduce the depth
32 of the cuttings bed and decrease torque and drag.

1 As a further refinement the simulator can be linked
2 into a risk based economic model that computes the
3 cost of various operational choices as presented by
4 the model and comparison with real time data. For
5 instance, rate of penetration and hole cleaning are
6 linked. The faster the rate of penetration the more
7 drill cuttings there are to be removed from the
8 well. The model will be able to determine the
9 probability of events such as stuck pipe given the
10 rate of penetration, cuttings bed build up and so
11 on. A risked economic decision can be made to
12 determine whether rate of penetration should be
13 maintained or reduced so as to reduce the likelihood
14 of getting stuck.

15

16 Referring now to Fig. 6, the operation of a virtual
17 reality simulator is demonstrated

18

19 Any number of design parameters is entered into the
20 model. These design parameters can be entered into
21 the model by:

22

- 23 • Manual data entry
- 24 • From real time rig and downhole sensors
- 25 • From a data library
- 26 • As an output from one or more engineering
- 27 algorithms within the simulator
- 28 • As an output from one or more engineering
- 29 algorithms from a remote simulator or other
- 30 engineering algorithm

- 1 • By manipulation of icons and graphics on the
- 2 virtual reality user interface

3

4 An initial model is developed using data entry from
5 one or more of the means above. The model
6 complexity is developed as data is entered into the
7 simulator.

8

9 Any design parameter used in more than one related
10 or unrelated engineering algorithm is concurrently
11 used in these engineering algorithms. For example
12 fluid flow rate is used in pressure algorithms, hole
13 cleaning algorithms, equipment performance
14 algorithms and so on. Conventionally, using flow
15 rate as an example, the engineer would have to call
16 on the flow rate data three times - once to
17 calculate flow rate, again to calculate hole
18 cleaning and again to calculate equipment
19 performance. Because the engineer has to
20 consciously call on the data each time there is the
21 potential that the update flow rate, in this example
22 is not called on to recompute one or more of the
23 algorithms.

24

25 By linking each design parameter to every
26 engineering algorithm that uses each design
27 algorithm all related algorithms are updated
28 concurrently. Thus changing one design parameter
29 affects the entire well design and not just a single
30 aspect of the well design.

31

1 If we now need to simulate the effects of changing a
2 number of design parameters at the same time the
3 whole system effects all the changes in design
4 parameter will be seen. Thus the positive and
5 negative effects of a range of design parameter
6 changes can be seen concurrently.

7
8 By having the total well design represented in
9 virtual reality the effects of the design change can
10 be readily and easily seen as a virtual reality
11 image of the well and near wellbore.

12
13 Fig. 6 shows the steps in the real time simulation
14 model. This process differs significantly from that
15 described in US4,794,534. The main difference is
16 that the comparison of performance against model is
17 automatic and does not rely on any interpretation of
18 a negative variance in performance. On the contrary
19 any positive variance in performance is used in the
20 predictive model to optimise future performance.

21
22 A further example of the invention will now be
23 described.

24
25 The above embodiments describe developing the well
26 plan within a set of constraints and conditions. In
27 the present example, the theoretical maximum depth
28 that can be drilled is determined from user inputs
29 and from computed results derived from user inputs.
30 This is the unconstrained case. There is then
31 calculated a theoretical maximum well depth based on
32 a set of user defined constraints. A further

1 theoretical well depth is then calculated based on a
2 further set of user defined constraints, where the
3 first set of constraints and the second set of
4 constraints are independent constraints. For
5 example, the first set of constraints may be related
6 to geological or reservoir conditions, and the
7 second set to surface facility conditions.

8

9 The well planner is then able to see:

10

- 11 - the absolute maximum possible
- 12 - the maximum within geological constraints,
13 which can then be manipulated as necessary
- 14 - the maximum within facility constraints, which
15 can also be manipulated.

16

17 By adding an economic model the well planner can
18 then see the costs incurred and benefits accrued if
19 action were taken to remove or adjust the
20 constraints.

21

22 For instance, a common constraint in underbalanced
23 drilling is the available supply of injection gas.
24 If more gas could be found, or logistics
25 arrangements made to supply more gas, then a longer
26 well could be drilled. The production benefit of
27 the extra well length can be compared with the
28 additional cost of the extra gas supply or the
29 logistics, and an economic decision made.

1 CLAIMS

2

3 1. A method of designing an oil well, comprising:

4 (a) defining a plurality of design parameters

5 each of which is determined by a number of input

6 data, the input data for at least some of the

7 parameters including one or more of the other

8 parameters;

9 (b) providing, for each of the design

10 parameters, conditions or constraints which must be

11 met;

12 (c) selecting input data for a first design

13 parameter such that the parameter falls within the

14 conditions or constraints;

15 (d) varying the input data for the first design

16 parameter to achieve an initial optimisation of the

17 parameter;

18 (e) for a second design parameter whose input

19 data includes the first parameter, selecting other

20 input data such that the second parameter falls

21 within the conditions or constraints;

22 (f) varying said other input data for the

23 second design parameter to achieve an initial

24 optimisation of the parameter;

25 (g) varying the input data for the first

26 parameter to further optimise the second parameter;

27 and

28 (h) repeating steps (e) to (g) for the

29 remaining design parameters.

30

31 2. A method according to claim 1, in which the

32 design parameters are selected from:

1 (a) Design well path - being the path the well will
2 take from the surface to and through the reservoir.

3 (b) Design casing scheme - being the placement,
4 size and material characteristics of the casing
5 cemented in the well.

6 (c) Design drill string - being the design of the
7 drill string, bottom hole assembly and drill bit
8 selection for each section of the well.

9 (d) Torque and drag calculations - being the
10 calculation of static and dynamic frictional drag in
11 the well bore due to the movement of the casing
12 and/or drill string during rotary operations.

13 (e) Drilling fluid design - being the design of the
14 drilling fluid and determination of rheological
15 properties.

16 (f) Hydraulics design - being the design of the
17 drilling fluid, flow rate, flow regime and pressure
18 regime along the drillstring, through the bit and
19 along the annulus.

20 (g) Pressure management - being the management of
21 the pressure in the wellbore and the balance between
22 the wellbore pressure, formation fluid pressure and
23 formation fracture pressure.

24

25 3. A system for use in oil well design,
26 comprising:

27 a database storing a plurality of design
28 parameters each of which is determined by a number
29 of input data, the input data for at least some of
30 the parameters including one or more other
31 parameters;

1 the database also storing for each parameter
2 conditions or constraints which must be met;
3 means for selecting input data for each of the
4 parameters;
5 calculating means for calculating a selected
6 parameter from its input data; and
7 means for optimising a given parameter by
8 altering the input data of another parameter which
9 forms an input to said given parameter.

10

11 4. The system of claim 3, in which the means for
12 selecting input data comprises a manual input device
13 such as a keyboard.

14

15 5. The system of claim 3, in which the means for
16 selecting input data comprises an input data
17 database from which items may be selected by a user.

18

19 6. An oil well design system in which design
20 parameters are presented to a user via a graphical
21 user interface.

22

23 7. The system of claim 6, in which the graphical
24 user interface comprises a virtual reality interface
25 or view.

26

27 8. The system of claim 6 or claim 7, in which the
28 system is in accordance with any of claims 3 to 5.

29

30 9. The system of claim 8, in which the graphical
31 user interface is adapted to display the degree of
32 system optimisation.

1

2 10. The system of claim 9, in which the degree of
3 system optimisation is displayed by a system of
4 traffic light displays.

5

6 11. A method of forming an oil well in which a
7 model of the predicted wellbore conditions is
8 constructed; real time data is generated by sensors
9 in the well and the drilling rig; said real time
10 data is used to compare the actual with the
11 predicted conditions and differences are used to
12 adjust drilling parameters or to adjust the model;
13 an updated model is created; and the process is
14 repeated as necessary.

15

16 12. The method of claim 11, in which the model is
17 constructed using the design method of claim 1 or
18 claim 2 or the system of any of claims 3 to 10.

19

20

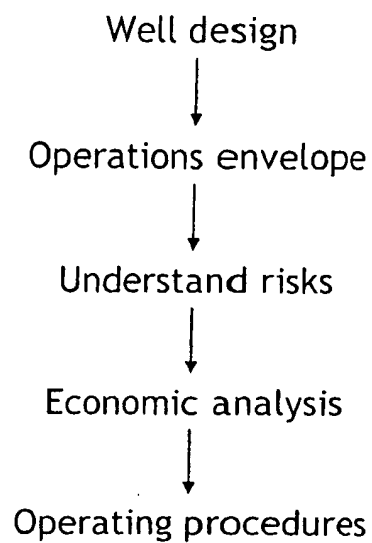


FIG. 1

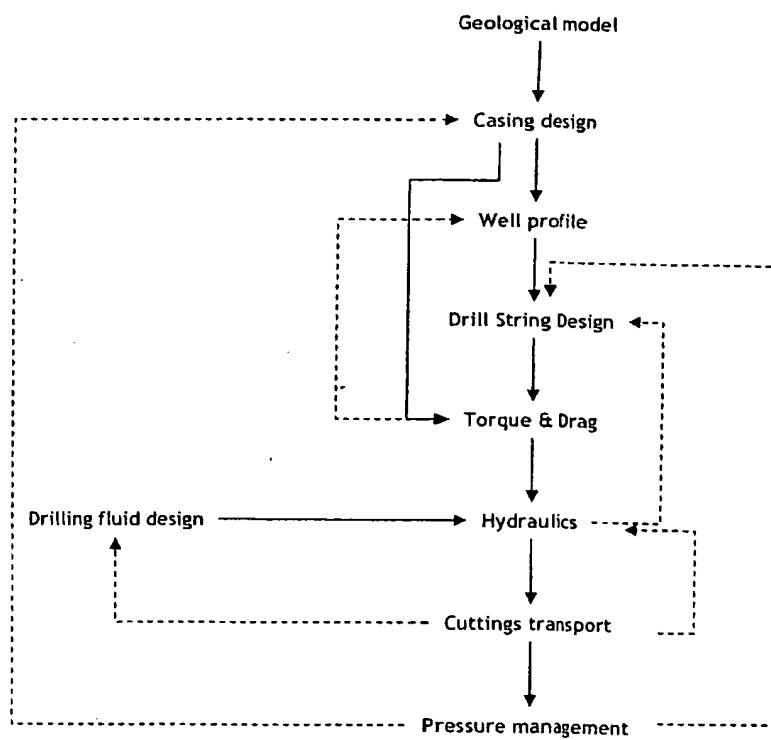


FIG. 2

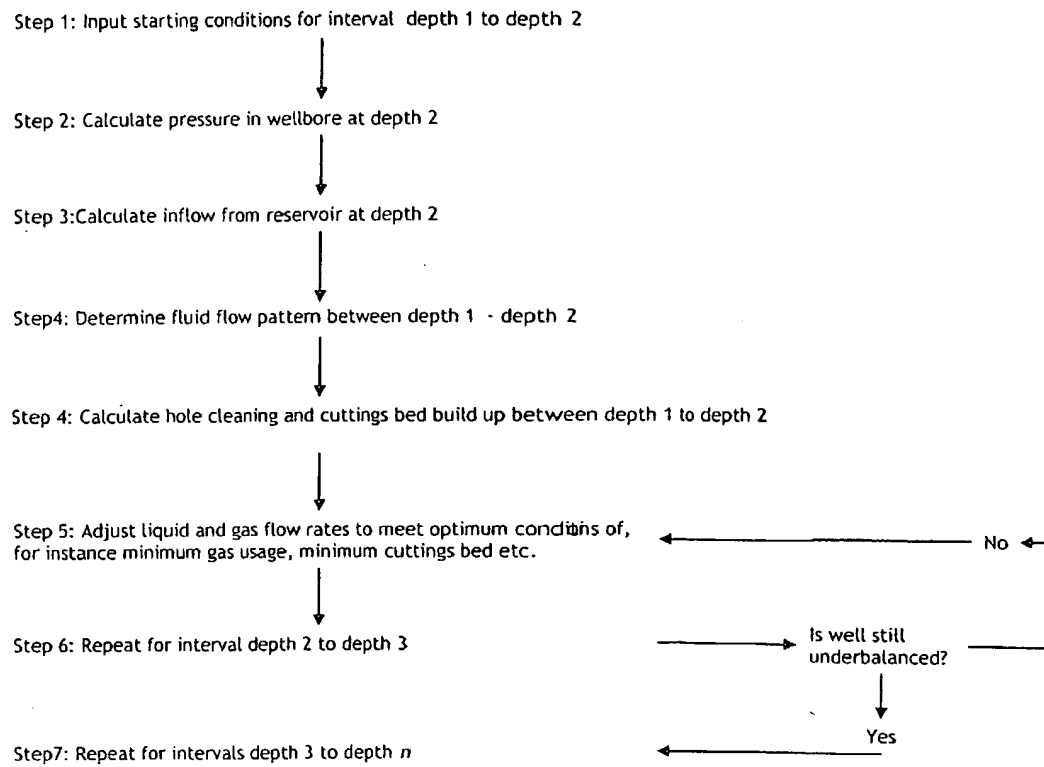


FIG. 3

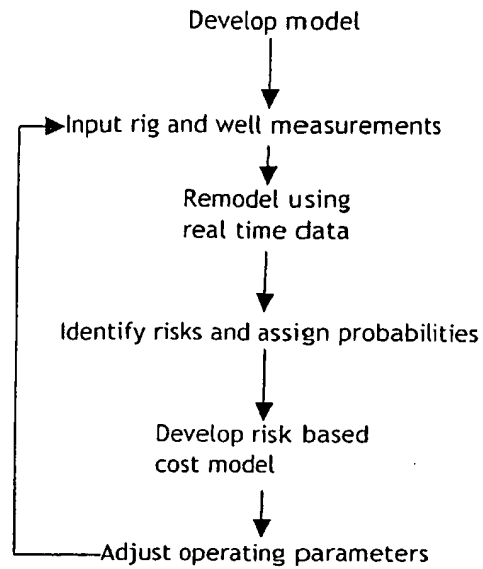


FIG. 4

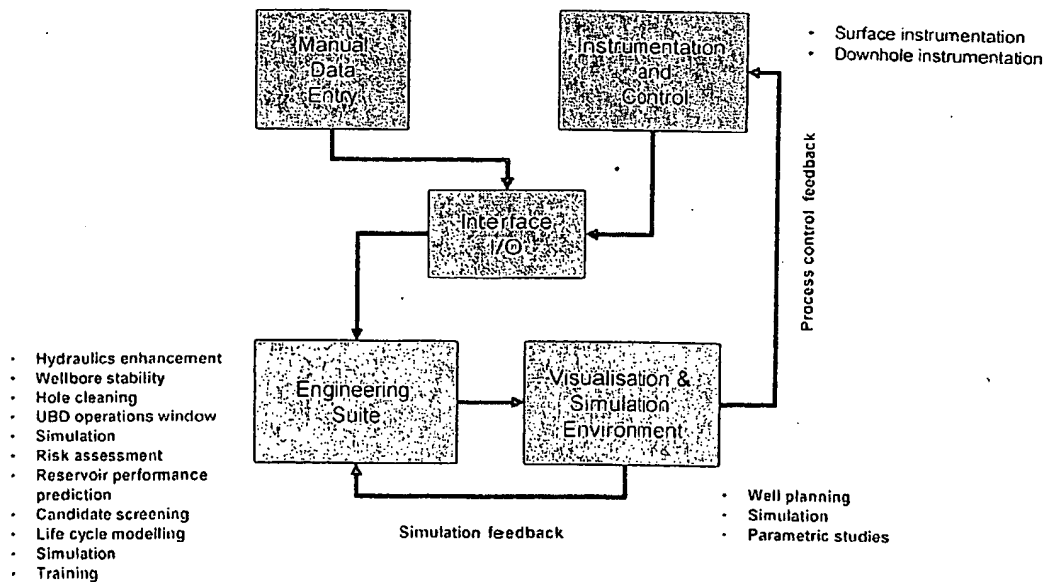


FIG. 5

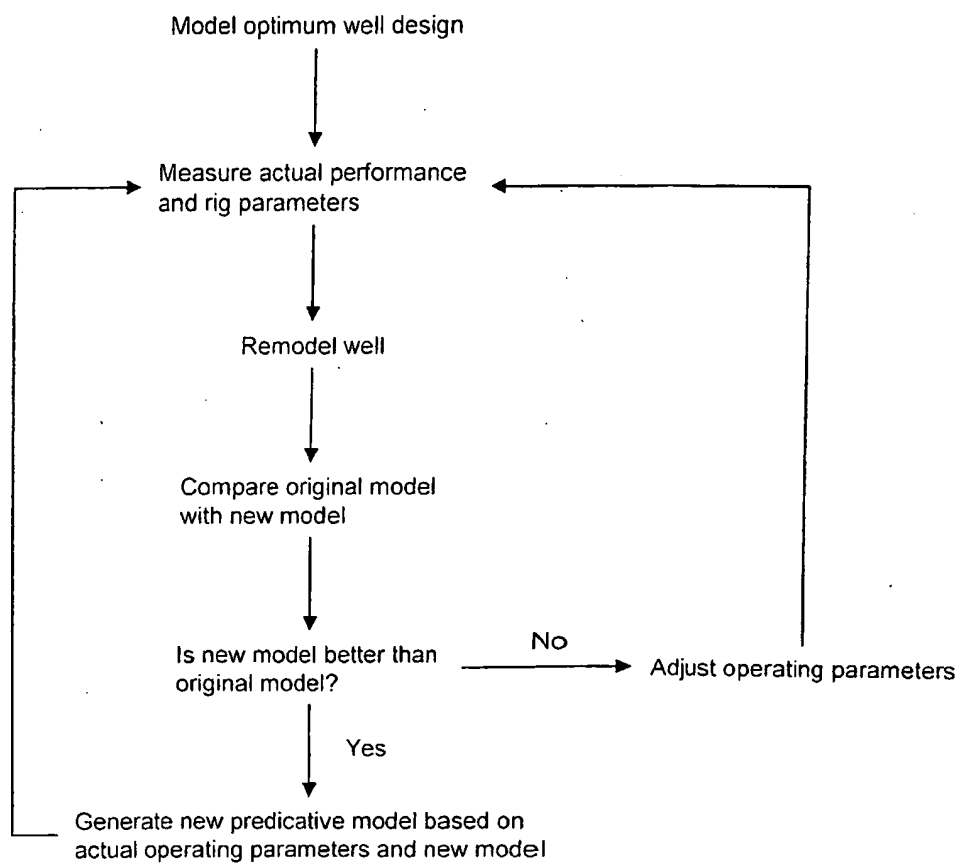


FIG. 6

TABLE 1

Step	Activity	Constraint	Iteration
1	Well path	Geological data Reservoir/target data Other well paths Maximum allowable dog leg	Optimisation 1 Optimisation 3 Optimisation 6 Optimisation 9 Optimisation 2 Optimisation 4 Optimisation 10
2	Casing design - geometric/biaxial	Geological data Reservoir data Maximum dogleg	Optimisation 5 Optimisation 7 Optimisation 11
3	Casing design - dynamic/triaxial	Maximum allowable tensile load Maximum allowable torsional load Minimise axial load (drag)	Optimisation 8 Optimisation 12 Optimisation 15
4.	Drill string design	Maximum allowable torsional load Maximum allowable tensile load Minimise axial load (drag)	Optimisation 13 Optimisation 16 Optimisation 18
5	Hydraulics	Maximum allowable pressure Minimum annular velocity Minimum cuttings bed Optimum bit hydraulics	Optimisation 17
6	Wellbore stability	Minimum wash out	

INTERNATIONAL SEARCH REPORT

International Application No
PC 17022005/003398

A. CLASSIFICATION OF SUBJECT MATTER E21B44/00 G06F17/50		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) E21B G06F		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal, TULSA		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2002/177955 A1 (JALALI ET AL.) 28 November 2002 (2002-11-28) paragraphs '0031!, '0032!, '0041!, '0123!, '0124!	11
A	-----	1,3
X	US 2003/168257 A1 (ALDRED ET AL.) 11 September 2003 (2003-09-11) paragraphs '0042!, '0043!	11
A	-----	1,3
A	US 2004/000430 A1 (KING) 1 January 2004 (2004-01-01) paragraphs '0092!, '0093!	1,3
A	-----	1,3
A	WO 03/072907 A (SCHLUMBERGER SURENCO SA. ET AL.) 4 September 2003 (2003-09-04) paragraphs '0032!, '0033!	1,3
<input type="checkbox"/> Further documents are listed in the continuation of box C. <input checked="" type="checkbox"/> Patent family members are listed in annex.		
* Special categories of cited documents : *A* document defining the general state of the art which is not considered to be of particular relevance *E* earlier document but published on or after the international filing date *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) *O* document referring to an oral disclosure, use, exhibition or other means *P* document published prior to the international filing date but later than the priority date claimed *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. *Z* document member of the same patent family		
Date of the actual completion of the international search 14 December 2005		Date of mailing of the international search report 21/12/2005
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016		Authorized officer Rampelmann, K

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